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REAL TIME TRANSFORMER HEALTH MONITORING SYSTEM USING GSM AND IoT

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Abstract - Electrical Transformers are the most important element in the process of transmission and distribution of electricity. Transformer is the costliest component of Electrical Industry. As we know, Distribution transformers are one of the most important equipment in power network and its correct functioning is vital to system operation. Because of, the large number of transformers distributed over a wide area in power electric systems, the data acquisition and conditioning monitoring is an important issue. This project represents the design and implementation of a mobile embedded system and novel software to monitor and diagnose condition of transformers, by record key operation indicators of a distribution transformer like load currents, transformer oil, oil temperature, winding temperature and voltage of three phases. The proposed on-line monitoring system integrates a Global Service Mobile (GSM) Modem, with standalone single chip microcontroller and sensor packages. Data of operation condition of transformer receives in form of SMS (Short Message Service) and will be saving in computer server. Using the suggested online monitoring system will help utility operators to keep transformers in service for longer of time.

Keywords: *Distribution Transformer; PIC Microcontroller; GSM/GPRS Module ; Sensors; Monitoring Unit; LCD display*

I. INTRODUCTION

Electricity plays an important role in our life. Every moment of our life depends upon electricity. Electricity has several components and equipment helping human to transfer and regulate the distribution according to usage. The most crucial equipment of transmission and distribution of electric power is transformer. In power systems, an electrical equipment distribution transformer directly distributes power to the low-voltage users and its operation condition is an important criterion of the entire network operation. The majority of these devices have been in service for many years in different (electrical, mechanical and environmental) conditions. They are the main components and constitute a large portion of capital investment. Operation of distribution transformer under rated condition (as per specification in their nameplate) guarantees their long service life. However, their life is significantly reduced if they are subjected to overloading, heating, low or high voltage/current resulting to unexpected failures and loss of supply to a large number of customers thus effecting system reliability. Abnormality in distribution transformer is accomplished with variation in different parameters like

- Load current
- Load voltage
- Oil level
- Oil temperature
- Winding temperature

Overloading, oil temperature, load current and ineffective cooling of transformer are the major cause of failure in distribution transformer. When a transformer fails, an adverse effect occurs in the continuity of transmission and distribution system resulting in increase of power system cost and decrease of reliability in electric delivery. As transformer is a combination of many parts, this all parts must be checked regularly to maintain the transformer in perfect operating conditions. The monitoring devices or systems which are presently used for monitoring distribution transformer have some problems and deficiencies. According to the above requirements, we need a distribution transformer real time monitoring system to monitor all essential parameters operation, and send to the monitoring center in time. It leads to online monitoring of main functional parameters of distribution transformers which will provide necessary information about the health of transformers. This will help and guide the utilities to optimally use the transformers and keep this equipment in operation for a longer period. Transformer Health Monitoring System will help to identify or recognize unexpected situations before any serious failure which leads to greater reliability and significant cost savings. Widespread use of mobile networks and GSM modems, have made them an attractive option both for voice media and wide area network applications.

II. BLOCK DIAGRAM

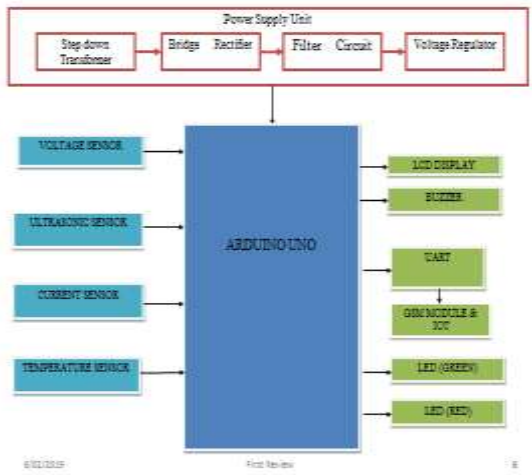

Fig – 1: Block Diagram

III. COMPONENT DESCRIPTION

1. SUPPLY CIRCUIT

The supply circuit is used to give the proper power supply to the circuits. The single phase AC 230volts is step down into 12V by step down transformer. The step down AC voltage is fed into the power supply circuit. The power supply circuit provides +5V,-5V, +12V,-12V. The arduino and LCD display requires 5V and driver circuit requires both 5V and 12V.

2. ARDUINO

Arduino is open-source hardware and software user community that designs and manufactures single- board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control both physically and digitally. Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of program to the on-chip flash memory. A program for Arduino hardware may be written in any programming language with compiler that produces binary machine code for the target processor. With help of this device we can read the input values using sensors and controls the measured parameters.

3. TEMPERATURE SENSOR

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius temperature. The LM35 is operated at -55^0 to +120^0 C. The LM35 can read the data using arduino and it can be stuck or established to a surface and its temperature will be within around the range of 0.01^0 C of the surface temperature. The output of LM35 temperature can be given to comparator circuit and can be used for over temperature indication.

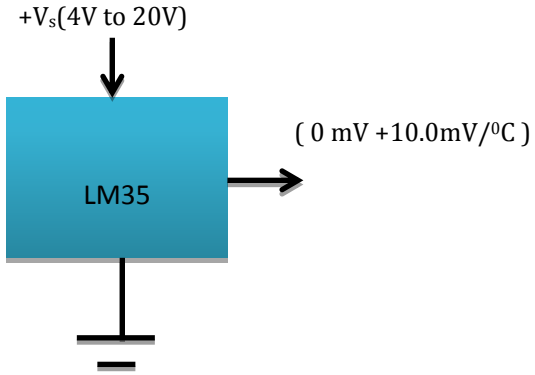

Fig.2 Temperature sensor

4. ULTRASONIC SENSOR

Ultrasonic sensors are used for distance measuring applications. These gadgets regularly transmit a short burst of ultrasonic sound to a target, which reflects the sound back to the sensor. The system then measures the time for the echo to return to the sensor and computes the distance to the target using the speed of sound within the medium. Different sorts of transducers are utilized within industrially accessible ultrasonic cleaning devices. An ultrasonic transducer is affixed to a stainless steel pan which is filled with a solvent and a square wave is applied to it, conferring vibration energy on the liquid. The ultrasonic distance sensors measures distance using sonar; an ultrasonic beat is transmitted from the unit and distance-to-target is determined by measuring the time required for the echo return. Output from the ultrasonic sensor is a variable width beat that compares to the distance to the target.

Fig.3 Ultrasonic sensor

5. CURRENT SENSOR

The allergo ACS712 current sensor is based on the principle of Hall Effect. According to this principle, when a current carrying conductor is placed into a magnetic field, a voltage is generated across its edges perpendicular to the directions of both the current and the magnetic field. It is used to measure the alternating high current. It steps down

ac current to lower value so that it can be easily read with the help of microcontroller.

Fig.4 Current sensor

6. LCD DISPLAY

An LCD is made with either a passive matrix or an active matrix display grid. The active matrix LCD is also known as a thin film transistor (TFT) display. The passive matrix LCD has a grid of conductors with pixels located at each intersection in the grid. A current is sent across two conductors on the grid to control the light for any pixel. An active matrix has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel. For this reason, the current in an active matrix display can be switched ON and OFF more frequently improving the screen fresh time.

7. IoT

The ESP8266 Wi-Fi module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your arduino device and get about as much WiFi ability as Wi-Fi offers. The ESP8266 module is an extremely cost effective board with a huge and ever growing community.

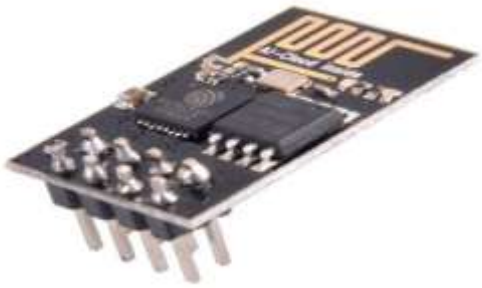

Fig. 5. ESP8266 Module

IV. RELATED WORK

The process of designing and implementation real time transformer health monitoring system is carried out by arduino. The step down transformer and power supply circuit is used to give supply to the arduino and LCD display. In this project parameters like voltage, current, oil level, oil temperature and winding temperature is sensed through the respective sensors. The sensed level values are given to the arduino.

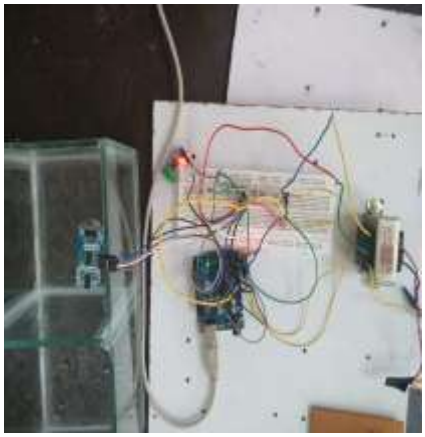

Fig. 6 Output of the related work

Arduino calibrates the given input values and it provides the necessary output as programmed in it. The programmed output is displayed through the local display LCD screen. The same output is also transmitted through the Wi-Fi module to the internet server programmed in the arduino. Data's will be saved and could be used for the further analysis. The GSM modem is used as a short message server (SMS) device that transmits parameters as an SMS.

V. PROPOSED WORK

The main objective of this project is to design and implement an embedded – mobile and IoT based system to measure Over voltage, Load current, Oil level, Oil temperature and Winding temperature.

VI. METHODOLOGY

Our work includes the process of monitoring the transformer performance in which the over voltage, over current, oil level, oil current and winding temperature is measured and it is compared with the nominal value in the comparator. If the measured value exceeds or decreases, the system will send an error alert to the concern person.

VII. Conclusion

A mobile monitoring system for distribution transformer was designed, implemented and tested. The designed system is connected to a distribution transformer and is able to record and send abnormal operating parameters information to a mobile device using a GSM network. The time to receive the SMS message varied from 2-10 seconds and this is due to the public GSM network traffic. The system hardware was constructed from off- the- shelf components. The experimental results came out as expected. A server module can be added to this system to periodically receive and store transformer parameters information about the entire distribution transformer of a particular utility in a database application. This database will be a useful source of information on the utility transformers. The stored data can be analyzed to help the utility in monitoring the operational behavior of their distribution transformers and identify faults before any catastrophic failures thus resulting in significant cost saving as well as improving system reliability.

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